DOCUMENT RESUME

ED 031 930 56 EM 007 283

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Programming the Instructional Film: Monograph One.
Arizona State Univ., Tempe. Classroom Learning Lab.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Report No-USOE-5-0269
Bureau No-BR-5-0269
Pub Date Oct 66
Contract-OEC-5-15-026
Note-41p.
EDRS Price MF-$0.25 HC-$2.15
Descriptors-Audiovisual Aids, Audiovisual Instruction, Autoinstructional Aids, Behavioral Science Research, *Behavior Change, Behavior Patterns, Classroom Techniques, *Film Production, Film Study, Instructional Films, Instructional Technology, *Production Techniques, Programed Instruction, *Programed Materials, Student Behavior, *Teacher Developed Materials, Teaching Techniques

Instructional technology, defined as the application to instruction of a primary or underlying science, refers in the present context to the science of human behavior with regard to problems of instruction and learning. Instructional films, though of a very high technical standard, and though widely used nowadays, are seldom constructed along the principles of programed instruction. A well-constructed programed film will exercise a high degree of internal control over the learner's responses. The learner is made to behave in a specifically prescribed manner throughout the course of, and at the end of the film, by the use of the instructional specification (IS) and through the IS, by the program outline. The components of the IS are terminal behavior, instructional cue, elicitors, and stimulus limits. This paper provides a blue-print for preparing an IS, and is one of five monographs that make up a demonstration kit for producing a self-instructional film. (CO)

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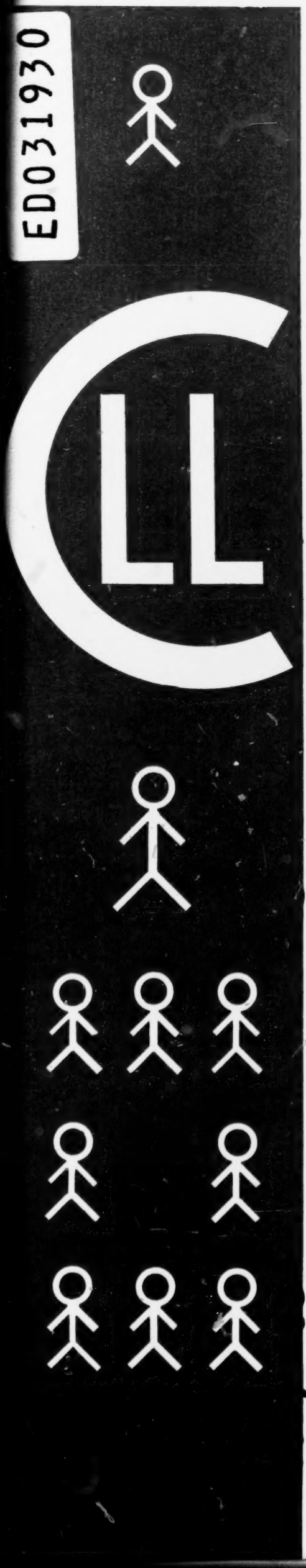

PROGRAMMING THE INSTRUCTIONAL FILM

MONOGRAPH #1

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USOE Project 5-0269

Contract No. OE 5-15-026

October 1966

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experimental analyses of student behavior

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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P R O G R A M M I N G T H E I N S T R U C T I O N A L F I L M

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The potential of the educational film for instructional purposes has captured the imagination of educators and film producers alike. The number of commercially available instructional films is increasing at an exponential rate, portending even greater utilization of this instructional medium. The increase in the production of films has been accompanied by marked improvement in production techniques. In general, producers of instructional films employ modern cinematographic techniques and produce films of a technical quality far superior to those produced a decade or two ago.

Likewise, programed instruction has had profound effects on education. Teaching machines and programed textbooks are available today to millions of American school children, and several important empirically derived principles of learning have been successfully employed in the development of effective programed materials. Yet, it is an extremely rare occasion when one reads of the application of these principles to motion picture films, tape recordings, charts, filmstrips, or any of the conventional AV media.

Though educators have discovered that the learner's response is a crucial element in the process of learning, they have been slow to demand instructional films which elicit specified responses. Neither have they demanded films which incorporate such instructional techniques as cueing and providing immediate knowledge of results, even though experts in instructional technology frequently emphasize the critical nature of such techniques.

This article presents (1) a discussion of some critical issues in the development of instructional films and (2) a set of procedures for the application of empirically derived principles of learning to the development of such films.

Control of Learner Responses

The amount of desired learning acquired from an instructional film or other instructional media is largely a function of the control exerted over the learner's behavior. There are two types of control, external and internal, and it is essential that a precise distinction be made between them.

External control is the control that the instructor maintains over the learner's behavior. It includes all techniques that the instructor employs to maintain a quiet room and to insure "looking-at-the-screen" behavior while the film is being shown. In addition, external control includes any academic activity related to the film that is assigned by the instructor. Questions or a test on topics covered in the film constitute examples of this type of external control if these activities are administered by the instructor.

Internal control refers to control over learner responses by stimuli contained in the film itself. These responses, of course, are the en route or terminal behaviors related to attainment of the instructional objectives of the film. Internal control exists when the appropriate stimulus conditions presented in the film elicit the desired response from the learner. For example, suppose that the objective (expressed in terms of learner behavior) for an instructional film is "to name the three classes of levers when shown pictures of examples from each class." At various points, the film shows a picture of an example of a first-class lever, accompanied by the question "What type lever is this?" The pictorial and verbal stimuli elicit from the learner the response "First-class lever." This response is controlled by stimuli presented in the film and is therefore a function of internal control.

It is important to note that the term "internal control" relates only to control of the film over the learner responses to be developed as en route or terminal behaviors. Take the lever example again. Internal control does not refer to the power of the film to elicit a "looking-at-the-film" response from the learner (even though this response is essential) because the "looking" response is not a component behavior of the objective "to name the three classes of levers." To put it differently, looking at the film is a necessary but not a sufficient condition for the acquisition of this "naming" behavior.

A well-constructed programed film, unlike nearly all instructional films now in existence, exercises a high degree of internal control over learner responses. The internal control is designed to provide for the development of specific responses in the learner. The elicitation of these responses is effected by means of the application of selected principles of learning. The internal control enables one to predict with high probability the specific responses that the learner will make to the filmed stimuli. This is not the case in the typical instructional film, where responses of the learner are not specified in advance and where there is no systematic attempt to relate specific responses to specific stimuli. In other words, the learning that may eventuate from using a typical instructional film cannot be predicted with confidence. When using the programed film, with its high degree of internal control, predictions concerning learning outcomes can be made at a relatively high level of confidence.

Stimulus-Oriented Vs. Response-Oriented Films

Programed and traditional films do not differ only in terms of internal control. They differ also with respect to the emphasis on stimuli and responses. The programed motion picture is response oriented, while the traditional film is stimulus oriented. That is, the traditional (or stimulus-oriented) film is described in terms of the stimuli presented in it. Consider, for example, this description of a currently available commercial film:

> Cell Division (Mitosis): Film uses generalized animal cell in the interphase resting stage to show the division of the nucleus which precedes fission of the whole cell.

Note that this statement, which describes the stimuli presented in the film, is designed to provide a general answer to the question "What does the film show or contain?"

In contrast, a response-oriented film is described in terms of the behaviors that the learner will be able to perform after having used the film. Therefore, in the response-oriented film, the emphasis is not "What does the film show or contain?" but rather "What does the learner do?" An example of a response-oriented description[1] for the film on cell division is provided below:

1. To name[2] the following objects, given visual representations of each: (a) cell, (b) nucleus, (c) nucleolus, (d) chromosome, (e) cytoplasm.

2. To describe[3] the process of mitosis.

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[1] A number of performance descriptions have been developed by the authors for use in their research activities. The precise definition of each term used in this paper is provided in a footnote at its first occurrence.

[2] Name - The learner supplies the correct verbal response (in speech or writing) to a referent or set of referents when the referent names are not specified.

[3] Describe - The learner generates and names the necessary categories of objects, object properties, events, or event properties relevant to the description of a designated referent. The learner should respond in sufficient detail so that there is a probability of approximately one that any individual who can identify the referent by actually seeing it or reading the textbook description of it can also identify it by hearing or reading the student's description.

Note that this description is response oriented because it indicates the behavior that the successful learner can perform after viewing the film. It does not merely describe the film's stimulus content.

Response-oriented and stimulus-oriented films differ not only in terms of the way in which they are described but also in terms of the instructional stimuli presented in the film. The response-oriented film is concerned with developing in the learner appropriate en route and terminal responses. Therefore, the selection of the stimuli to be filmed is a function of their power to mediate or elicit appropriate student responses. In the stimulus-oriented film, however, the emphasis is on the presentation of a relatively wide range of stimuli. The relationship of these stimuli to the learning task is not clearly specified in advance because generally the film producer does not define a learning task (or learner behavior). Thus, the stimulus-oriented film normally contains a wider range of instructional stimuli than the response-oriented film, but less attention is devoted by the film producer to the power of these stimuli to control specific learner responses.

The Programed Film

What are the ingredients of a programed instructional film? To determine the appropriate stimulus content, one must first specify the behavioral objective(s) of the film in operational terms. That is, the behavior that the learner is to manifest after viewing the film must be described in terms such that the teacher or any competent observer can distinguish between individuals who exhibit the behavior and those who do not. It is essential that the objective of the film be stated in terms of observable behavior for two reasons: (1) this enables one to employ the film to systematically develop in the learner both the en route and desired terminal behaviors, and (2) it enables one to observe learner behavior to determine whether the desired learning actually has occurred.

A set of systematic procedures is needed for specifying the content material for response-oriented programed films possessing a high degree of internal control. The procedures below were developed by the staff of the Classroom Learning Laboratory at Arizona State University. They have been successfully employed by staff members to produce a number of silent self-instructional films. They have also been used by advanced media specialists to produce programed silent films under the direction of the authors in several NDEA Institutes and workshops.

The procedures employed in determining the stimulus content involve a two-phase process. The first phase is the specification of the film's objectives and the stimulus conditions essential for the attainment of the objectives. This is accomplished through use of the Instructional Specification (IS) strategy (2,3). The second phase in the process involves development (from the IS) of a program outline, which lists in order the precise pictorial and textual stimuli to be presented in each sequence in the film and the specific length and condi-

tions of each sequence. The program outline serves as a blueprint for the technical task of assembling and filming the content materials. The procedures for developing a set of IS's and a program outline for an instructional task are described in detail in the remainder of the article.

Preparing the Instructional Specifications (IS)

The IS provides a strategy for outlining the elements which are essential to an instructional system. The IS is applicable to virtually any instructional system. Researchers in the Classroom Learning Laboratory at Arizona State University have used it as a basis for such diverse tasks as writing technical manuals (1), preparing course guides (4), and writing programed textbooks (2). An IS has four components, each of which is defined here and explained and illustrated in the remainder of this section.

The Components of the IS

1. Terminal Behavior. The terminal behavior is the behavior that the IS is designed to develop in the learner.

2. Instructional Cue. The instructional cue is the information presented to the learner to mediate the terminal behavior.

3. Elicitors. Elicitors are statements or questions which elicit from the learner either the terminal behavior or responses that the learner must acquire before the instructional cue can function to mediate the terminal behavior.

4. Stimulus Limits. The stimulus limits are composed of two types of stimuli. The S 's are the class(es) of stimuli that are to control or elicit the terminal behavior. The S 's are the class(es) of stimuli that serve as improper stimuli for eliciting the terminal behavior.

The precise specification of the learner's entering behavior must be antecedent to the development of an IS. This may be accomplished in one of two ways. The behavior may be stated in one or more operational statements which would be identical in form to the behavioral objectives described below. They would describe in behavioral language the response class or classes which the learner must possess before entering the instructional sequence.

The entering behavior may also be defined in terms of a minimum acceptable score on a readiness test designed to measure the behaviors which are a prerequisite to the successful use of the self-instructional film. The entering

behaviors are those measured by the readiness test, and the readiness test reveals which learners can enter the program. The readiness test serves also as a predictor of learner success in the program, and the IS is developed to function as an effective instructional instrument for those learners whom the test identifies.

The Terminal Behavior. To illustrate the process of preparing an IS, this article uses an instructional task appropriate for intermediate and upper-grade science classes. The subject unit for the example is entitled "Observation and Inference." The medium is an 8mm silent film. The IS's for this task or any other instructional program cannot be developed until the behavioral objectives of the program have been identified. The objective of the present lesson is "to distinguish[4] between statements of observation and statements of inference, given objects and/or events to which the statements refer." As defined below, this means that when presented with an eliciting stimulus such as "Is this a statement of observation or a statement of inference?" the learner can make an observable response (speaking, pointing, writing, etc.), correctly classifying each given statement referring to specified objects or events. This objective does not mean that the learner must name or label a given statement. Rather, the name will be given him in the question or in the eliciting stimulus.

If the objective for a film encompasses subordinate (or antecedent) behaviors, an IS must be developed for each class of behavior that the learner is to acquire from the film. In the present example, certain antecedent behaviors must be identified and developed in the learner before he can distinguish between statements of observation and statements of inference. These antecedents are (1) to

[4]Distinguish - The learner indicates the class membership of specified referents belonging to one of two or more classes whose names are given. The referents to be classified must include exemplars from at least two of the given classes.

identify[5] statements of observation and (2) to identify statements of inference. Thus, the film requires the development of three IS's, one for each of the two antecedent behaviors and one for the final criterion behavior. An IS, then, must be developed for each of these behaviors:

Given objects and/or events to which the statements refer,
1. To identify statements of observation
2. To identify statements of inference
3. To distinguish between statements of observation and statements of inference

The completed IS for the first of these tasks is presented in Table 1.

INSERT TABLE 1 HERE

As in the case of the total instructional task, the first step in constructing an IS is the specification of the terminal behavior. The terminal behavior of the first IS for the present task is "to identify statements of observation". This means that the learner must respond correctly (either by writing or underlining the correct responses or by pointing, touching, speaking, etc.) to eliciting stimuli such as "Is this a statement of observation?" and "Which is a statement of observation?" To identify statements of observation, then, the learner must make correct observable discriminations of both exemplars and nonexemplars of statements of observation.

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[5]Identify - The learner indicates membership or nonmembership of specified objects or events in a single class when the name of that class is given.

The Instructional Cue. The second essential component of the IS is the instructional cue. Before the learner can identify statements of observation in the present task, he must be supplied with one or more instructional stimuli which he can use to mediate the correct identifying behavior. There is one cue that can always be used to mediate the behavior of identifying statements of observation: "A statement of observation tells what you see." The information presented in this cue enables the learner to correctly identify exemplars of statements of observation. Instructional cues are always verbal statements which can be used to mediate the verbal or nonverbal terminal responses called for in the terminal behavior.

An IS may require one or more instructional cues, depending on the entering behavior of the learner and the complexity of the instructional objective. In the exemplar under consideration, the nature of both the task and the instructional cue is such that the learner must be able to identify what he sees before the instructional cue given above can mediate the behavior "to identify statements of observation." If the learner were unable to identify what he sees, another instructional cue would be required. Only after the learner could "identify what he sees" would it be feasible to present to him the instructional cue "A statement of observation tells what you see."

The instructional cue must possess sufficient power to mediate the response of interest. It must, at the same time, be free of all stimuli which are not needed. That is, it should present the learner only with that information which is required to mediate the desired response. The instructional cue must be simple and straightforward if it is to be maximally effective. If the instructional cue is too complex, the programer who writes his program outline on the

basis of an IS (as described below) frequently finds flaws in the instructional cue. The better the instructional cue, the less complex will be the subsequent task of writing the program outline.

Elicitors. The terminal behavior for the present task is "to identify statements of observation." The film provides for the acquisition and maintenance of responses by presenting stimuli designed to elicit the desired responses from the learner. These stimuli, called elicitors, are designed to elicit either (1) responses that the learner must have in his repertoire before he can use the instructional cue to mediate the desired behavior or (2) the desired response itself. Responses of the latter type indicate whether or not the instructional cue is functioning to mediate the desired behavior.

In the example cited above, it is clear that if the instructional cue is to mediate the desired learner behavior, the learner must be able to discriminate between those statements telling what he sees and those describing something he cannot see. Therefore, an elicitor is provided that is designed to elicit from him the response of correctly identifying exemplars and nonexemplars of statements describing what he sees. The elicitor below serves this purpose.

1. (Given a pictorial stimulus of a boy eating a red apple)
   Do you see that:
   (a) The apple is red. (b) The apple is sweet. (c) The boy is hungry.
   (d) The boy is eating the apple. (e) The boy likes the apple...?

The learner who responds correctly to the elicitor above possesses the antecedent behavior for using the instructional cue to mediate the desired behavior, "to identify statements of observation." The next elicitors are designed to elicit from the learner the desired terminal behavior. The two elicitor cues

that are employed to elicit this behavior are:

2. (Given a pictorial stimulus of a car moving, an aerial on the right front fender visible)
   Is this a statement of observation?
   (a) The car is moving. (b) The car's motor is running. (c) The car has a radio. (d) The car has an aerial....
3. (Given a visual stimulus of a girl laughing at a blue book which she is holding)
   Which is a statement of observation?
   (a) The book is funny.
       The girl is laughing.
   (b) The girl is happy.
       The book is in the girl's hands....

The elicitors are sequenced in the IS in such a way that those listed first require the learner to make lower-level discriminations. Those presented subsequently require more complex discriminations that are built upon the responses elicited by the earlier elicitors. For example, the learner must be able to make the discrimination required by the first elicitor before the instructional cue can function to mediate the desired behavior. Therefore, the instructional cue is introduced in the filmed instructional sequence only after the learner has responded to several items based on the first elicitor. Elicitors 2 and 3 follow elicitor 1 in the IS because correct responses to these cues can be made only after the learner has acquired the behavior elicited by cue 1. The correct response to the final elicitors will always be the terminal behavior specified in the IS. This provides for the acquisition and maintenance of the desired behavior during the instructional sequence.

The elicitor is generic rather than specific in form. Frequently, several specific elicitors requiring responses at a similar level of complexity may be generated from a single generic elicitor in the IS by introducing variations in form. Elicitor 2 above, "Is this a statement of observation?" is an example.

From it, elicitors in any of the following forms can be developed:

a. Is "The car is moving" a statement of observation?
   Yes-No
b. "The car is moving" (is, is not) a statement of observation.
c. "The car is moving" is a statement of observation.
   True-False
d. Is "The car is moving" a statement of observation? _____

The Stimulus Limits. The population boundaries, or stimulus limits, of the stimulus class that controls the desired response represent the final component of the IS. Two classes of discriminative stimuli are specified in the IS. First, it is necessary to specify the S^D's. The S^D's are a general class of discriminative stimuli that are to control the desired response serving as the terminal behavior. In addition, it is necessary to specify the S^Δ's. The S^Δ's are improper stimuli for the response serving as the terminal behavior, but they do possess the capability of controlling this response.

To illustrate, consider a traffic light. Suppose that the desired response for the learner is "to go." That is, the learner is "to go" at the proper time, but he is not "to go" at any other time. The stimulus which controls this "going" is the green light. The green light, then, is an S^D, or the stimulus to which the learner makes the desired response, "to go." The yellow and the red lights should not cause him to go. The response of "going" is inappropriate in the presence of a yellow or red light. These stimuli, then, are S^Δ's; they are stimuli for "not going" rather than for "going." Note that in this example there is a finite number of S^D's and S^Δ's, one of the former and two of the latter. In other tasks, there frequently are large numbers of S^D's and S^Δ's, rather than the small number in the traffic light situation.

For the first IS, the learner is to identify as a statement of observation each statement that tells what he sees. Therefore, the S^D's, or class of stimuli which the learner should identify as statements of observation, are "any and all statements that describe something that is visible to the observer." Any given stimulus that is a member of this class, such as the statement "The girl is laughing" from elicitor 3 above, is an example of an S^D and, as such, it should elicit from the learner a response that identifies it as a statement of observation. However, the stimulus limits section of the IS includes only the general class(es) of stimuli (as contrasted with the specific examples from elicitor 3) that are to control the desired response.

Now, the response that the learner makes to S^D's should not generalize to stimuli which are similar to an S^D but which are not statements of observation. That is, he should not identify as statements of observation those stimuli which are not statements of observation (S^Δ's) but which may be confused with them. For this reason, the film must also provide for acquisition and maintenance of the response of identifying stimuli that are not statements of observation as nonexemplars of the stimulus class "statements of observation."

For example, certain stimuli have characteristics similar to statements of observation even though they are not statements of observation. This is particularly true of statements which describe something that the learner cannot actually see but which is so commonly inferred from what he does see that he "takes it for granted." Take the statement from elicitor 2, "The car has a radio." This is not a statement of observation because one cannot directly observe that the car has a radio. However, the learner has so frequently associated the presence of an aerial with the presence of a radio that he may nevertheless identify this

statement and other similar ones as statements of observation. To make correct identifications, the learner must identify any statement describing something that he infers from an observation (but cannot actually see) as a nonexemplar (S^{Δ}) of the stimulus class "statement of observation." Thus, the S^{Δ}'s are "all statements describing something not directly visible to the observer but readily inferred from visible objects or events."

Obviously, the selection of S^{Δ}'s to be included in the IS is a function of the best judgment of the individual developing the IS. One could have selected as S^{Δ}'s for the present IS "all statements describing something not directly visible to the observer" (whether or not it is readily inferred). Members of this stimulus class would include not only such specific examples as "The car has a radio" but also statements such as "The car is going to Chicago" and "The car has plastic seat covers." Since there is a low probability that the learner will identify as statements of observation those statements describing something that is not readily inferred from an observation, the stimulus class specified in the S^{Δ}'s does not include them. Likewise, there is a very low probability that the learner will identify questions as statements of observation, so they are not included as S^{Δ}'s. The S^{Δ}'s should always be stimuli that could be confused with the S^{D}'s and thus possess the potential of controlling a wrong response.

The first IS is now complete. Table 1 above shows the components of the completed IS, which subsequently will be employed to develop the first section of the program outline.

Before the program outline is developed, the IS for the entire program outline must be completed. This means that an IS must be developed for each of the

other two classes of behavior to be shaped by the film.

The second behavior, "to identify statements of inference, given objects and/or events to which the statements refer," thus becomes the terminal behavior for the second IS.[6]

The instructional cue for identifying statements of inference is: "A statement of inference tells what you guess but cannot see." Again, the function of the instructional cue is to mediate the learner behavior stated in the instructional objective.

The first elicitor, "Do you guess that...?" elicits from the learner a response that he must be able to make before the instructional cue can mediate the desired behavior. The final elicitors in the IS, it will be recalled, always are designed to elicit the terminal behavior. Thus, elicitors 2 and 3--"Is this a statement of inference?" and "Which is a statement of inference?"--require the learner to identify statements of inference.

The S^D's are "all statements describing something the observer guesses but cannot see." In other words, the learner should identify as a statement of inference any stimulus that falls within this class. The S^Δ's for this IS are "all statements describing something visible to the observer." The learner should acquire the behavior of identifying these stimuli as nonmembers of the stimulus class "statements of inference." Specific statements from the S^Δ's enable one to determine whether the learner has acquired this behavior.

The final IS for the film does not require a new instructional cue or statement of limits. The instructional cues provided earlier mediate learner acquisition of the terminal behavior, and the stimulus limits from the first two IS's also serve as the limits for this task.

[6]Copies of the second and third IS's and the complete program outline are available in Table 2.

The final IS does contain a new elicitor: "Tell whether each statement is a statement of observation or a statement of inference." It is designed to elicit from the learner the behavior "to distinguish between statements of observation and statements of inference." This is the terminal behavior that serves as the instructional objective for this IS. In addition, it will be recalled that the behavioral objective of the film is the same as that for the final IS. The film is thus programed in such a way that the last elicitor(s) from the final IS are structured to elicit the terminal behavior that the film is designed to develop. Therefore, correct responses to items from the final elicitor provide evidence that the film's objective has been attained.

The completed set of IS's provides an outline of the stimulus conditions essential for attainment of the film's objective. This set of materials now serves as a blueprint from which the program outline for the film is developed.

Preparing the Program Outline

The program outline is the detailed, step-by-step specification of the content and sequence of the pictorial and textual stimuli which will constitute the film. It would not be possible in an article of this length to present a detailed course in program writing. To a high degree, however, those principles of programing that are well known to the experienced programer apply whether one is preparing a programed textbook or a programed film. Therefore, this section deals only with the problems and procedures that either are unique to the programed film or are of particular concern in programing instructional films. Sections of the program outline developed from the IS's for "Observation and Inference" are presented below to provide an example and to illustrate the programing procedures discussed.

The first frames of a program include some element of the entering behavioral repertoire of the learner and an element which is related to the terminal behavior. The eliciting question or statement in these opening frames normally is a form of elicitor 1 in the first IS for the film. The specific stimulus (S^P or S^Δ) that accompanies the elicitor is selected from the stimulus classes listed as S^D's and S^Δ's in the stimulus limits section of the IS. These specific S^D's and S^Δ's presented along with the elicitors in the frames of the program outline may be taken directly from those listed with the elicitor in the IS, or they may be generated by the programer as he develops the program. The eliciting question in the opening frames of the "Observation and Inference" program outline (see below) is "Does this tell what you see?" Note that this question is a form of elicitor 1 from the first IS, and the specific S^D (The apple is red) and S^Δ (The apple is sweet) that accompany it in the opening frames are taken directly from the IS.

The instructional cue from the IS is introduced in the program only after the learner has demonstrated acquisition of the antecedent behavior that is required before the instructional cue can mediate the desired behavior. As noted in the section below, for example, the learner must be able to tell what he sees before the instructional cue "A statement of observation tells what you see" can function to mediate the behavior "to identify statements of observation." Therefore, after several frames have been employed to elicit "telling-what-he-sees behavior" from the learner, the instructional cue is gradually introduced into the program.

Pictorial Stimulus[7]	Textual Stimulus	Seconds
1. Red apple	The apple is red. Does this tell you what you see? Yes No	10
2.	Yes! You see that the apple is red.	5
3. Boy eating a red apple.	The apple is sweet Does this tell what you see?	9
4.	No. You do not see that the apple is sweet.	4
5. Boy eating a red apple.	The boy is eating his lunch. Does this statement tell what you see?	10

There is no fixed procedure for introducing the instructional cue. It may be introduced gradually through feedback to student responses. This is the case in the present program outline, where it is stated in essence as seen below in frames 8, 10, and 13 before the verbatim statement is first presented in frame 16.

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[7]The pictorial stimuli and textual stimuli from each frame are presented simultaneously in the same film scene. That is, frame 1 represents one scene, and the pictorial and textual stimuli from it are presented together in the first scene of the film, etc. The Seconds column indicates the duration of each scene.

	Pictorial Stimulus	Textual Stimulus	Seconds
8.		Yes. This is a statement of observation. It tells what you see.	6
9.	Boy eating a red apple.	The boy is hungry. Does this tell what you see?	8
10.		No. A statement of observation tells something you see, not what you have to guess.	7
11.	Boy eating a red apple.	The boy is bigger than the apple. Is this a statement of observation?	9
12.		Yes, it is a statement of observation because it tells what you see.	5
13	Boy eating a red apple.	The boy likes the apple. Is this a statement of observation?	9
14.		No. This is not a statement of observation. It does not tell what you see, but something you have to guess.	10
15.	Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car is moving. Is this a statement of observation?	8
16.		Yes, a statement of observation tells what you see.	4

On the other hand, it would be equally feasible to introduce the instructional cue in verbatim form without initially using the term "statement of observation" in several frames preceding its introduction. In this case, it would be appropriate to include in the same frame an elicitor whose correct answer requires the learner to use the information presented in the instructional cue.

Following the introduction of the instructional cue, the programer employs the elicitors from the IS that are designed to indicate whether the instructional cue is functioning to mediate the desired behavior. After the instructional cue for statements of observation has been introduced, then, the elicitors that require the learner to identify statements of observation are employed in the program. Elicitor 2, "Is this a statement of observation?" appears

in frames 13-23 in the program (see frames 13-16 above):

	Pictorial Stimulus	Textual Stimulus	Seconds
21.	Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car has a radio. Is this a statement of observation?	10
22.		No.	2
23.	Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car is not out of gas. Is this a statement of observation?	9

Elicitor 3, "Which is a statement of observation?" is also designed to elicit the terminal behavior for the first IS, and it is employed in frames 27-31.

	Pictorial Stimulus	Textual Stimulus	Seconds
27.	Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	Which is a statement of observation? The book is funny. The girl is laughing.	11
28.		The girl is laughing. A statement of observation always tells what you see.	9
29.	Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	Which is a statement of observation? The girl is enjoying the book. The girl is turning a page of the book.	15
30.		The girl is turning a page of the book. You can't see whether she's enjoying the book. You can see her turn the page.	12
31.	Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	The girl is happy. The book is in the girl's hands. Which is a statement of observation?	14

Therefore, the correct response to these frames is the terminal behavior specified for the first IS ("to identify statements of observation").

Now the program moves to the next IS. Again, the beginning frames for this IS employ an element from the learner's behavioral repertoire and one related to the terminal behavior for the IS. Thus, in frame 33, the program continues to refer to statements of observation but introduces the term "guess," which is a key word in the instructional cue and first elicitor for the second IS.

	Pictorial Stimulus	Textual Stimulus	Seconds
33.	Thermometer showing 105. Environment must show clearly that thermometer is outside.	The thermometer shows a temperature of 105. Do you see this or do you guess it?	12

The program is then developed from the second IS by working through the first elicitor, "Do you guess that...?" and then gradually introducing the instructional cue. The term "statement of inference" first appears in frame 42, and the verbatim instructional cue from the IS for statements of inference is presented in frame 50.

	Pictorial Stimulus	Textual Stimulus	Seconds
41.	Smoke rising from box, fire not visible.	There is fire in the box. Does this statement tell something you guess but cannot see?	14
42.		Yes. It is a statement of inference. It tells something you guess but cannot see.	9
43.	Smoke rising from box, fire not visible.	Something is burning. Does this statement tell something you guess but cannot see?	13

The eliciting questions from frames 45-57 follow the initial introduction of the instructional cue and are designed to elicit the terminal behavior for

the second IS. These questions are derived from elicitors 2 and 3 from the IS for statements of inference.

Pictorial Stimulus	Textual Stimulus	Seconds
45. Smoke rising from box, fire not visible.	There is heat in the box. Is this a statement of inference?	9
46.	It's a statement that tells something you guess but cannot see, so it <u>is</u> a statement of inference. The answer is <u>yes</u>.	11
53. Man before class. He is writing on chalkboard. Pupils are clearly visible.	The man is writing. The man is a teacher. Which is a statement of inference?	10
54.	You <u>see</u> that the man is writing, but you <u>guess</u> that he is a teacher. "The man is a teacher" is a statement of inference.	14

The remainder of the program outline is developed from the remaining IS in the same manner as the earlier parts were developed in the example. Note that from frame 60 through the conclusion of the "Observation and Inference" program, the eliciting questions are designed to require the learner to distinguish between statements of observation and statements of inference.

Pictorial Stimulus	Textual Stimulus	Seconds
60. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man is leaving the store. Observation? Inference?	10
61.	Observation. A statement of observation tells something you see.	6
70. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man has been shopping. Observation? Inference?	8
71.	Inference.	2

Thus, correct responses to the final frames presented in the film indicate that the learner has acquired the terminal behavior: "to distinguish between statements of observation and statements of inference." In addition, the present program has a "built-in" provision for maintenance. Both identifying statements of observation and identifying statements of inference are lower-order behaviors in the response hierarchy, which terminates with distinguishing between the two. Thus, the identifying behavior is instrumental for the terminal behavior, and provision for maintenance is built into the program.

Since the terminal behavior is to be controlled by a complex set of stimuli (i.e., a textual stimulus which states something about a visual stimulus), it is crucial that both the textual and the visual stimuli be presented simultaneously. Take frames 41 and 51 as an example.

Pictorial Stimulus	Textual Stimulus	Seconds
41. Smoke rising from box, fire not visible.	There is fire in the box. Does this statement tell something you guess but cannot see?	14
51. Smoke rising from box, fire not visible.	The smoke is rising. Is this a statement of inference?	9

If the textual stimulus were presented first and then withdrawn in favor of the pictorial stimulus, the learner would read a statement about a phenomenon which he has not seen. Then, when the pictorial stimulus was presented, the statement would no longer be visible. Or if the opposite precedure were followed, the learner would have no pictorial referent for the statement. Such a procedure would require the learner to remember the critical stimulus elements from the preceding exposure without simultaneously providing him with verbal cues indicating which elements were critical. In short, the learner would

not know which stimulus elements to attend to. Therefore, the two sets of stimuli must be presented simultaneously for a sufficient length of time to allow the learner to attend separately to both sets.

The writer of the programed textbook has a relatively limited number of modes for presentation of feedback in comparison with the number available to the producer of the programed film. To mention only a few possibilities: The film may present feedback at a precise time; it may provide it as a subsequent superimposed textual stimulus; it may provide it in an animated sequence; or it may utilize a mode which is available to the writer of a programed text. Frames 53 and 54 above provide an example. The feedback is provided separately in frame 54 after the pictorial and textual stimuli have been withdrawn. Perhaps it would be sufficient to have frame 54 state only "The man is a teacher." However, since the question of frame 53 is no longer available to the learner, the answer includes the substance of the question: "The man is a teacher" is a statement of inference. In addition, the feedback frame again includes instructional material. The learner is told why statement of inference is the proper choice: "You <u>see</u> that the man is writing, but you <u>guess</u> that he is a teacher."

While the present article is not concerned with cinematography as such, a word should be said about the storyboard. The IS together with the program outline completely eliminates the necessity for a storyboard. The programer needs to "tell himself" the properties of the pictorial stimuli. Even if he has a considerable degree of artistic competence, little or nothing will be gained by attempting to sketch the pictorial stimuli. At best, such sketches provide no more precise cues for selecting the pictorial stimuli than does

the verbal description of the pictorial stimulus in the program outline. Frequently, the precision of well-chosen words is needed to clearly specify the fine-grain details. The writer of the program outline will find that the storyboard plays an insignificant role even in cases when another individual does the cinematography. In this situation, the cinematographer might choose to sketch a scene for the approval of the programer if the verbal description allows for any ambiguities. Whatever role the storyboard plays, however, it is quite clear that it has little usefulness if the program outline is poor, and it is superfluous if the program outline is good.[8]

Finally, some indication of time of each scene is necessary if a programed film is planned for use in a conventional projector. In the absence of empirical data on optimal length of stimulus presentation, the film may be produced using the film maker's rule of thumb: allow enough time to read the textual material aloud twice at a slow rate. An additional second or two is allowed whenever a frame requires a response from the learner. If the programer's intuition leads him to believe that the length of frames determined on this basis might be too long or too short, he will make appropriate modifications. Some projectors will stop at predesignated points to allow the learner to make his response, and they will start again on signal from the learner. If a pacing which is responsive to the learner is desired, certainly this type of projector is indicated. The programer must take such factors into consideration when completing his program outline.

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[8]The writers' experience with commercial film producers has strengthened this conviction. The commercial producer does not want us to provide him with a storyboard, nor does he use one himself. The reasons are manifold, but the most important one is that the still picture on a storyboard tends to inhibit rather than facilitate the conceptualization of the potential of the motion picture as a medium.

Summary

Instructional technology has been defined in two ways. It may mean the application of mechanical or electromechanical tools to instructional problems. In a more sophisticated sense, it refers to the applications to instruction of a primary, or underlying, science. In the present context, this would refer to the science of human behavior (or, more specifically, human learning) to problems of instruction. The science is at the disposal of educators. The hardware is available. If, then, a true instructional technology is to emerge, it will be a result of the application of experimentally derived principles of learning to the utilization of new instructional media.

The production of instructional films is an area to which empirically derived principles of learning can be applied. As instructional technologists and film makers work together in the type of application suggested in this article, two results should accrue: (1) the quality of instructional films will improve, and (2) new data will emerge which will enable the instructional technologist to refine instructional theory and practice.

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Reprinted from AV Communication Review, Volume 14, Number 3, Fall 1966.
Teaching Machines and Programed Instruction .

Table 1

Instructional Specifications for
"Observation and Inference"

Instructional Specifications for Identifying Statements
of Observation

Terminal Behavior: To identify statements of observation, given objects and/or events to which the statements refer.

Instructional Cue: A statement of observation tells what you see.

Elicitors:

1. Do you see that...
   (a) the apple is red, (b) the apple is sweet, (c) the boy is hungry, (d) the boy is eating the apple, (e) the boy likes the apple, etc.

   (Given a pictorial stimulus of a boy eating a red apple)

2. Is this a statement of observation?
   (a) The car is moving. (b) The car's motor is running. (c) The car has a radio. (d) The car has an aerial, etc.

   (Pictorial stimulus of a rapidly moving car with an aerial)

3. Which is a statement of observation?
   (a) The book is funny. The girl is laughing.
   (b) The girl is happy. The book is in the girl's hands.
   etc.

   (Pictorial stimulus of girl laughing at a blue book which she is holding)

Stimulus Limits:

S^D	S^Δ
All statements that describe something visible to the observer.	All statements describing something not directly visible to the observer, but readily inferred from visible objects or events.

Instructional Specification for Identifying Statements of Inference

Terminal Behavior: To identify statements of inference, given objects and/or events to which the statements refer.

Instructional Cue: A statement of inference tells what you guess, but cannot see.

Elicitors:

1. Do you guess that...
   (a) it is a hot day, (b) the thermometer reads between 100° and 110°, (c) there are numbers on the thermometer, (d) it is summertime, etc.

   (Pictorial stimulus: Outside thermometer reading 105°)

2. Is this a statement of inference?
   (a) The smoke is rising. (b) There is fire inside the box. (c) Some smoke is higher than the box. etc.

   (Pictorial stimulus: Smoke rising from a box)

3. Which is a statement of inference?
   (a) The man is writing. The man is a teacher.
   (b) The children are seated. The children can read.
   etc.

   (Pictorial stimulus: Man in front of school class writing on board)

Stimulus Limits:

S^D	S^Δ
All statements describing something the observer guesses, but cannot see.	All statements describing something visible to the observer.

Instructional Specification for Distinguishing between Statements of Observation and Statements of Inference

Terminal Behavior: To distinguish between statements of observation and statements of inference, given objects and/or events to which the statements refer.

Instructional Cue: As given in the preceding two Instructional Sepcifications.

Elicitors: Tell whether each statement is a statement of observation or a statement of inference.

(a) The man bought some groceries.
(b) The man is leaving a grocery store.
(c) The man is walking.
(d) The bag is full of groceries.
(e) The man is carrying a bag.
(f) The man has been shopping.

(Pictorial stimulus: Man leaving a store on foot and carrying a bag with groceries protruding from the top)

Stimulus Limits:

Statements of Observation

S^D	S^Δ
As stated in IS number 1.	As stated in IS number 1.

Statements of Inference

S^D	S^Δ
As stated in IS number 2.	As stated in IS number 2.

Table 2

"Observation and Inference"

IS's and Program Outline

Film #1

Pictorial Stimulus	Textual Stimulus	Seconds
1. Red apple	The apple is red. Does this tell what you see? yes no	10
2.	Yes. You see that the apple is red.	5
3. Boy eating a red apple.	The apple is sweet. Does this tell what you see?	9
4.	No. You do not see that the apple is sweet.	4
5. Boy eating a red apple.	The boy is eating his lunch. Does the statement tell what you see?	10
6.	No. The statement does not tell what you see.	5
7. Boy eating a red apple.	The boy has a red apple. Does this tell what you see?	9
8.	Yes. This is a statement of observation. It tells what you see.	4
9. Boy eating a red apple.	The boy is hungry. Does this tell what you see?	8
10.	No. A statement of observation tells something you see, <u>not</u> what you have to guess.	7
11. Boy eating a red apple.	The boy is bigger than the apple. Is this a statement of observation?	9

The pictorial stimuli and textual stimuli from each frame are presented simultaneously in the same film scene. That is, frame 1 represents one scene and the pictorial and textual stimuli from it are presented together in the first scene of the film, etc.

Pictorial Stimulus	Textual Stimulus	Seconds
12.	Yes, it is a statement of observation because it tells what you see.	5
13. Boy eating a red apple.	The boy likes the apple. Is this a statement of observation?	9
14.	No. This is not a statment of observation. It does not tell what you see, but something you have to guess.	6
15. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car is moving. Is this a statement of observation?	8
16.	Yes, a statement of observation tells what you see.	4
17. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car's motor is running. Is this a statement of observation?	10
18.	No. You cannot see the motor.	4
19. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car has an aerial. Is this a statement of observation?	9
20.	Yes. It tells what you see. It is a statement of observation.	6
21. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car has a radio. Is this a statement of observation?	10
22.	No.	2
23. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car is not out of gas. Is this a statement of observation?	9
24.	No. A statement of observation tells what you see. You cannot see whether the car has gas or not. You can only guess it.	10

Pictorial Stimulus	Textual Stimulus	Seconds
25. Car moving, no parked or standing cars visible. Aerial on front fender is clearly visible.	The car is moving forward. Is this a statment of observation?	9
26.	Yes.	2
27. Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	Which is a statment of observation? The book is funny. The girl is laughing.	14
28.	The girl is laughing. A statement of observation always tells what you see.	11
29. Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	Which is a statement of observation? The girl is enjoying the book. The girl is turning a page of the book.	15
30.	The girl is turning a page of the book. You can't see whether she's enjoying the book. You can see her turn the page.	8
31. Girl seated, looking at book which she holds in her hands. She is laughing heartily. She turns a page.	The girl is happy. The book is in the girl's hands. Which is a statement of observation?	14
32.	The book is in the girl's hands.	4

End of Film #1

Film #2

	Pictorial Stimulus	Textual Stimulus	Seconds
33.	Thermometer showing 105°. Environment must show clearly that thermometer is outside.	The thermometer shows a temperature of 105°. Do you see this or do you guess it?	14
34.		You see that it is 105°. It is a statement of observation.	5
35.	Thermometer showing 105°. Environment must show clearly that thermometer is outside.	It is summertime. Did you see this or guess it?	8
36.		You guess that it is summertime even though you cannot see what season it is in this picture.	6
37.	Thermometer showing 105°. Environment must show clearly that thermometer is outside.	It is a hot day. Does the statement tell something that you guess, but cannot see?	12
38.		The statement tells something you guess but cannot see. The answer is yes.	5
39.	Thermometer showing 105°. Environment must show clearly that thermometer is outside.	The thermometer shows a temperature between 100° and 110°. Does the statement tell something that you guess but cannot see?	20
40.		No. The statement tells something you see.	4
41.	Smoke rising from box, fire not visible.	There is a fire in the box. Does the statement tell you something you guess but cannot see?	14
42.		Yes. It is a statement of inference. It tells something you guess but cannot see.	6
43.	Smoke rising from box, fire not visible.	Something is burning. Does the statement tell something you guess but cannot see?	13

Pictorial Stimulus	Textual Stimulus	Seconds
44.	This is another statement of inference because it tells something you guess but cannot see. The answer is yes.	9
45. Smoke rising from box, fire not visible.	There is heat in the box. Is this a statement of inference?	9
46.	It's a statement that tells something you guess but cannot see so it is a statement of inference. The answer is yes.	11
47. Smoke rising from box, fire not visible.	Some smoke is higher than the box. Is this a statement of inference?	11
48.	The statement doesn't tell something you guess. It tells something you see so it is not a statement of inference. The answer is no.	11
49. Smoke rising from box, fire not visible.	There is some smoke in the box. Is this a statement of inference?	11
50.	Yes. A statement of inference tells something you guess but cannot see.	6
51. Smoke rising from box, fire not visible.	The smoke is rising. Is this a statement of inference?	9
52.	No. The statement tells what you see.	4
53. Man before class. He is writing on chalkboard. Pupils are clearly visible.	The man is writing. The man is a teacher. Which is a statement of inference?	14
54.	You see that the man is writing, but you guess that he is a teacher. "The man is a teacher" is the statement of inference.	11
55. Man before class. He is writing on chalkboard. Pupils are clearly visible.	The children are seated. The children can read. Which is the statement of inference?	14

Pictorial Stimulus	Textual Stimulus	Seconds
56.	The children can read.	3
57. Man before class. He is writing on chalkboard. Pupils are clearly visible.	The children are in school. The man writies with his right hand. Which is the statement of inference?	16
58.	The children are in school.	7

End of Film #2

Film #3

Pictorial Stimulus	Textual Stimulus	Seconds
59.	In the next scenes, tell whether each statement is a statement of observation or a statement of inference.	8
60. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man is leaving the store. Observation? Inference?	10
61.	Observation. A statement of observation tells something you see.	6
62. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man bought some groceries. Observation? Inference?	10
63.	Inference. A statement of inference tells something you guess, but can't see.	7
64. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man is walking. Observation? Inference?	10
67.	Inference.	2
68. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man is carrying the bag. Observation? Inference?	10
69.	Observation.	2
70. Man walking from grocery store, carrying bag with packages of breakfast cereal protruding from top.	The man has been shopping. Observation? Inference?	10
71.	Inference.	2

End of Film #3